

1 CLAIMS

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3 1. A downhole tool for selectively performing a task in
4 a well bore, the tool comprising a substantially
5 cylindrical body having a central bore running
6 axially therethrough, a sleeve located within the
7 bore, the sleeve including a ball seat, a plurality
8 of balls, each ball having substantially similar
9 dimensions and each ball arresting a majority of
10 fluid flow through the bore when located in the ball
11 seat, mechanical biasing means located between the
12 sleeve and the body to bias the sleeve in a first
13 direction, and functional means on the body to
14 perform a task in the well bore, the functional
15 means being operable on relative movement of the
16 sleeve, wherein the functional means has at least a
17 first and a second operating position, each change
18 in position being effected by passing a said ball
19 through the sleeve in a reverse direction, and
20 wherein the said changes form a cyclic pattern such
21 that the functional means can be cycled back to the
22 first operating position.

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24 2. A downhole tool as claimed in Claim 1 wherein
25 the ball seat releasably retains each ball.

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27 3. A downhole tool as claimed in Claim 1 or Claim 2
28 wherein the balls are deformable.

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30 4. A downhole tool as claimed in Claim 1 or Claim 2
31 wherein the ball seat is a deformable ball seat
32 which flexes to release the ball.

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- 1 5. A downhole tool as claimed in Claim 4 wherein the
2 deformable ball seat comprises a spring such as a
3 disc spring.
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- 5 6. A downhole tool as claimed in Claim 1 or Claim 2
6 wherein the ball seat comprises a helical channel on
7 an inner surface of the sleeve.
8
- 9 7. A downhole tool as claimed in any one of Claims 4 to
10 6 wherein the balls are of a non-pliable material
11 and thus cannot deform.
12
- 13 8. A downhole tool as claimed in any preceding Claim
14 wherein the mechanical biasing means is a strong
15 spring.
16
- 17 9. A downhole tool as claimed in any preceding Claim
18 wherein a chamber exists between the sleeve and the
19 body which acts as a damper during movement of the
20 sleeve relative to the body.
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- 22 10. A downhole tool as claimed in any preceding Claim
23 wherein a choke ring is located around the sleeve to
24 provide a damping action by forcing passing fluid to
25 slow down as the sleeve moves relative to the tool
26 body.
27
- 28 11. A downhole tool as claimed in any preceding Claim
29 wherein the tool further comprises engagement means
30 to control relative movement between the sleeve and
31 the body.
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1 12. A downhole tool as claimed in any preceding Claim
2 wherein said engagement means comprises at least one
3 index pin located in a profiled groove which extends
4 around the tool.
5

6 13. A downhole tool as claimed in any preceding Claim
7 wherein the tool further includes a ball non-return
8 element.
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10 14. A downhole tool as claimed in Claim 13 wherein the
11 element is a split ring located on a ramp within the
12 bore.
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14 15. A downhole tool as claimed in any preceding Claim
15 wherein the tool includes a ball arrester.
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17 16. A downhole tool as claimed in Claim 15 wherein the
18 arrester comprises a plurality of surfaces
19 transversely arranged to the central bore to provide
20 a convoluted path which a ball must take through the
21 sleeve.
22

23 17. A downhole tool as claimed in any preceding Claim
24 wherein the tool further comprises a second ball
25 seat, located below the sleeve.
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27 18. A downhole tool as claimed in Claim 17 wherein the
28 second ball seat comprises a collet including a
29 plurality of fingers directed in the first direction
30 operated by the sleeve.
31

32 19. A downhole tool as claimed in Claim 17 wherein the
33 second ball seat comprises a trapped 'C' ring.

1 20. A downhole tool as claimed in Claim 17 wherein
2 the second ball seat is a shuttle arrangement,
3 wherein the relative position of shuttle elements
4 provide a seat to prevent passage of a ball.
5

6 21. A downhole tool as claimed in any preceding Claim
7 wherein the tool is a circulation tool.
8

9 22. A downhole tool as claimed in Claim 21 wherein the
10 functional means comprises at least one first port
11 arranged substantially transversely to the central
12 bore through the body, and at least one second port
13 arranged transversely to the central bore through
14 the sleeve, such that alignment of the ports causes
15 fluid to be discharged from the central bore and
16 wherein alignment of the ports is controlled by
17 relative movement of the sleeve.
18

19 23. A downhole tool as claimed in any preceding Claim
20 wherein the tool includes ball collecting means.
21

22 24. A method of circulating fluid in a borehole, the
23 method comprising the steps:
24

- 25 (a) inserting in a work string a tool comprising a
26 tubular body including a plurality of first
27 radial outlet ports in which is located a
28 sleeve including a plurality of second radial
29 outlets;
30 (b) running the work string and tool into a
31 borehole, with the sleeve in a first position
32 relative to the body wherein the first and

1 second radial outlets are arranged in a first
2 operating position;

3 (c) dropping a ball into the work string such that
4 the ball lands on the sleeve and forces the
5 sleeve into a second position relative to the
6 casing wherein the first and second radial
7 outlets are arranged in an intermediate
8 operating position and fluid flow is restricted
9 by the ball; and

10 (d) increasing pressure behind the ball to cause
11 the ball to pass through the sleeve, the
12 releasing pressure allowing the sleeve to move
13 to a third position relative to the body
14 wherein the first and second radial outlets are
15 arranged in a second operating position; and
16 wherein the ports are aligned in a either of
17 the operating positions and misaligned in the
18 other operating position.

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20 25. A method as claimed in Claim 24 wherein the method
21 further includes the steps of:

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23 (e) dropping a second ball, identical to the first
24 ball, into the work string such that the second
25 ball lands on the sleeve and forces the sleeve
26 into the second position relative to the body
27 wherein the first and second radial outlets are
28 arranged in the intermediate operating position
29 and fluid flow is restricted by the second
30 ball; and

31 (f) increasing pressure behind the second ball to
32 cause the second ball to pass through the
33 sleeve, the releasing pressure allowing the

sleeve to move to the first position relative to the body wherein the first and second radial outlets are arranged in the first operating position.

26. A method as claimed in Claim 24 or Claim 25 wherein the method includes the step of moving the sleeve against a mechanical bias.

27. A method as claimed in any one of Claims 24 to 26 wherein the method includes the step of controlling movement of the sleeve relative to the body by use of an index sleeve.

28. A method as claimed in any one of Claims 24 to 27 wherein the method includes the step of decelerating the ball as it passes from the sleeve to dissipate the pressure.

29. A method as claimed in any one of Claims 24 to 28 wherein the method includes the step of stopping the ball in a second ball seat after it has passed through the sleeve.

30. A method as claimed in Claim 29 wherein the method further includes the step of preventing fluid flow through the work string while directing it through the radial ports.

31. A method as claimed in any one of Claims 24 to 30 wherein the method includes the step of catching the dropped balls in the work string.

1 32. A ball arrester for dissipating momentum of a ball
2 after it has passed through a ball seat, the
3 arrester comprising a substantially cylindrical body
4 in which is located a non-linear pathway through
5 which the ball is guided.
6

7 33. A ball arrester as claimed in Claim 32 wherein the
8 pathway comprises a plurality of surfaces
9 transversely arranged to a central bore.
10

11 34. A ball seat for a downhole tool, the ball seat
12 comprising a plurality of part cylindrical sleeves
13 which can shuttle with respect to each other,
14 longitudinally in the tool, wherein a ball can only
15 pass through the seat when the sleeves are located
16 at their longitudinal extent.
17

18 35. A ball seat for a downhole tool as claimed in Claim
19 34 wherein at least a first sleeve is stationary
20 while at least a second sleeve moves thereover.
21

22 36. An actuation mechanism for a downhole tool, the
23 mechanism comprising a substantially cylindrical
24 body having a central bore running axially
25 therethrough, a sleeve located within the bore, the
26 sleeve including a deformable ball seat,
27 mechanical biasing means located between the sleeve
28 and the body to bias the sleeve in a first direction
29 and a ball, wherein the deformable ball seat
30 releasably retains the ball to prevent fluid flow
31 through the sleeve and cause the sleeve to move in
32 the reverse direction relative to the body and

1 wherein on release of the ball the seat returns to
2 its original dimensions.

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4 37. An actuation mechanism as claimed in Claim 36
5 wherein the ball seat comprises a spring.

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7 38. An actuation mechanism as claimed in Claim 37
8 wherein the spring is a plurality of disc springs in
9 a layered structure.

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11 39. An actuation mechanism for a downhole tool, the
12 mechanism comprising a substantially cylindrical
13 body having a central bore running axially
14 therethrough, a sleeve located within the bore, the
15 sleeve including a helical channel on an inner
16 surface, mechanical biasing means located between
17 the sleeve and the body to bias the sleeve in a
18 first direction and a ball, sized to run in the
19 helical channel in a reverse direction to prevent a
20 majority of fluid flow through the sleeve and cause
21 the sleeve to move in the reverse direction relative
22 to the body.

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24 40. An actuation mechanism as claimed in Claim 39
25 wherein the mechanical bias is a strong spring.

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27 41. An actuation mechanism as claimed in Claim 39 or
28 Claim 40 wherein the helical channel has a left hand
29 thread so that a ball travelling through the seat
30 travels in the opposite direction to the rotation of
31 the work string.

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- 1 42. An actuation mechanism as claimed in Claim 41
- 2 wherein a pitch of the thread is greater than or
- 3 equal to a diameter of the ball intended to pass
- 4 therethrough.